Water Balancein North Indian Ocean

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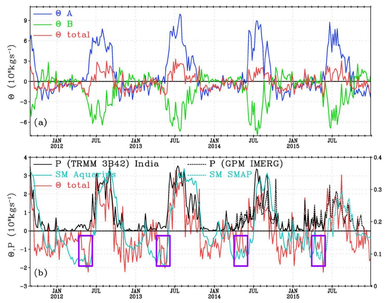

Fig. 1 (a) Time series of moisture transport (**Θ**) from the Arabian Sea to land integrated along coastline (blue), **Θ** from the Bay of Bengal to land integrated along coastline (green), positive for onshore flow, and the net transport to land (red), computed by subtracting green line values from blue line values. (b) Time series of spatially integrated precipitation (black) and averaged soil moisture (cyan), over land bounded by 72° E-85° E and 10° N-30° N, and net **Θ** (red) from (a).

Just before the summer rain starts (June), the net transport is negative; there is more moisture moving out to the Bay of Bengal than coming from the Arabian Sea, with low soil moisture marked by boxes. During this short period moisture is drawn to the Bay of Bengal before it is replenished by moisture from the Arabian Sea.

We found that the southwest (summer) Monsoon onsets, as observed by the Advanced Scatterometer (ASCAT) in the two embayments of the North Indian Ocean, are preceded by a surge of sea surface temperature (SST) measured by the Tropical Rainfall Measuring Mission (TRMM) Microwave Imager (TMI) above the deep convection threshold, and the changes occur earlier in the Bay of Bengal than in the Arabian Sea (Liu and Xie 2017).

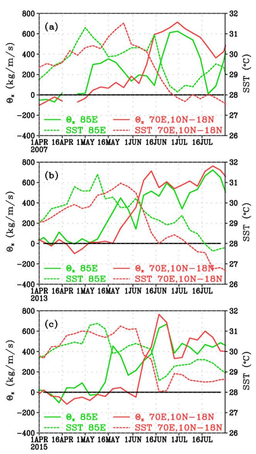

Fig. 2 Integrated moisture transport Θ (solid line) and SST (broken line) averaged from 10ºN to 18ºN along 85ºE in the Bay of Bengal (green), compared with those along 70ºE in the Arabian Sea (red), between April and July for 2007 (a), 2013 (b), and 2015 (c). All data are 5 day averages.

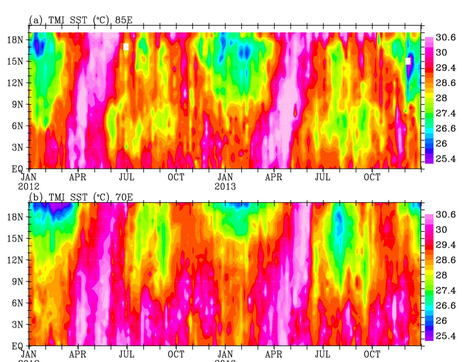

Fig. 3 Time-latitude cross sections of SST from TMI along 85ºE in the Bay of Bengal (a) and along 70ºE in the Arabian Sea (b).

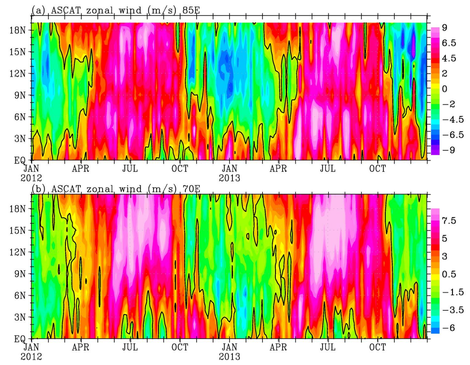

Fig. 4 Same as Fig. 3, except for zonal component of surface wind from ASCAT.

The surface shortwave radiation, which is the major surface thermal forcing, derived from the Moderate-Resolution Imaging Spectroradiometer (MODIS), is strong through the entire pre-monsoon season in both embayments.

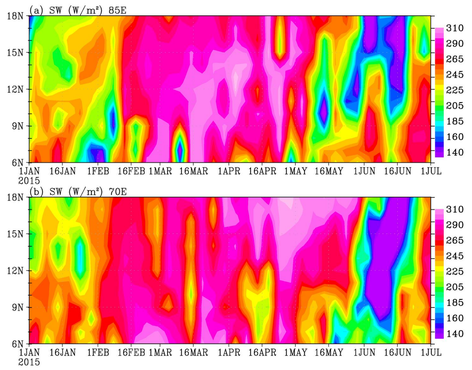

Fig. 5 Time-latitude cross sections of shortwave radiation from MODIS along 85ºE in the Bay of Bengal (a) and along 70ºE in the Arabian Sea (b).

The SST surges are found to coincide with a shallowing of the ocean mix-layer exhibited by an ocean general circulation model.

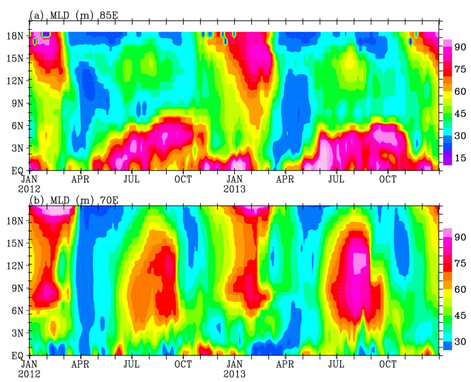

Fig. 6 Same as Fig. 3, except for mixed layer depth derived from the 5 day averaged temperature fields of Estimating the Circulation & Climate of the Ocean (ECCO) model output.

The onset of summer monsoon is marked by rain episodes, revealed by the Global Precipitation Measurement (GPM), with clear mesoscale signatures on top of the seasonal reversal of salinity advection, as observed by the Soil Moisture Active Passive (SMAP). The rain episodes also have clear correspondence with the intraseasonal variation of surface shortwave radiation; both are related to cloud cover. Radiation and hydrologic forcing are found to be closely related in the intraseasonal time scales.

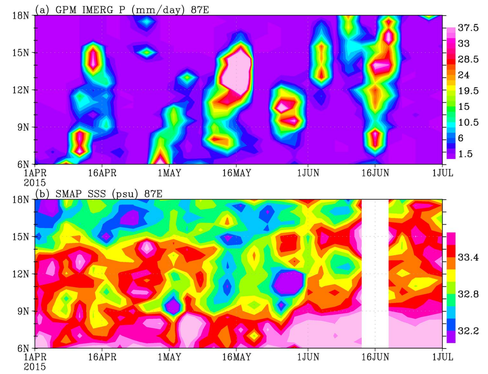

Fig. 7 Time-latitude cross sections of (a) surface rain rate from GPM, and (b) salinity from SMAP along 87ºE in the Bay of Bengal.

Reference

Liu, W.T., and Xie, 2017: Premonsoon Drought in India Observed from Space. J. Hydrometeor., 18, 683-692. DOI: 10.1175/JHM-D-16-0014.1